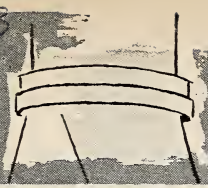
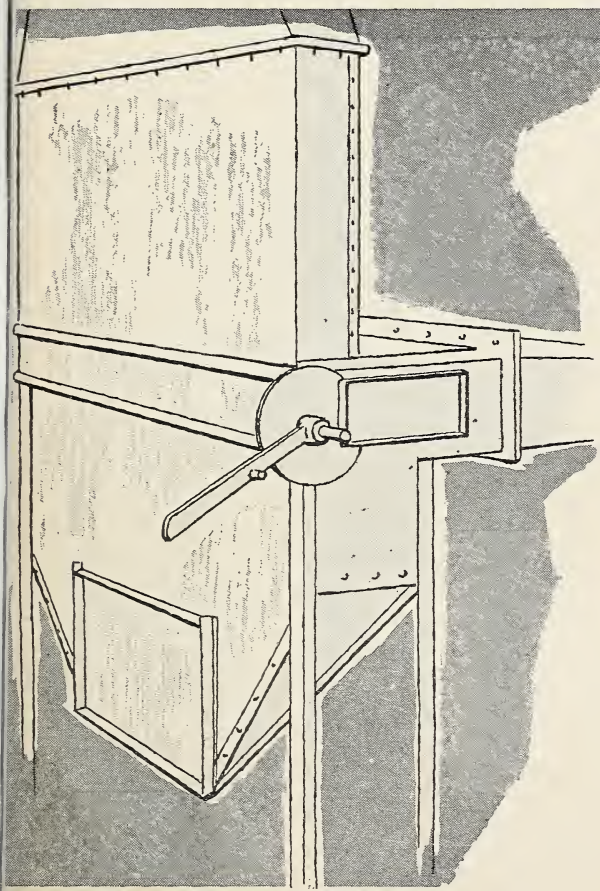


FOREIGN-MATTER TRAP for Cotton Gins



A Device for the Removal of Green Bolls and Other Heavy Objects from Seed Cotton at the Gin

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By Gerald N. Franks, *agricultural engineer*, and A. Clyde Griffin, Jr., *physicist*, *Agricultural Engineering Research Branch, Agricultural Research Service*

NEED FOR A DEVICE TO REMOVE GREEN BOLLS AND TRAMP METAL FROM COTTON

Extraneous material in seed cotton has been a problem to the ginner since the first cotton gin was placed in operation. In the early days, hulls and trash were separated from the cotton by hand, and some of the early patents granted on gin machinery covered devices especially designed to remove the rocks, sticks, and other foreign matter found in the cotton at the time of ginning. Later, the double-rib huller gin, cleaner feeders, and bur extractors were all developed for that purpose. The equipment developed from these first devices performs fairly well in the removal of hulls, leaf trash, and other similar foreign material normally contained in hand-harvested cotton and the cleaner types of spindle-picked cotton, but improvements are still possible.

The invention and use of sleds, strippers, and mechanical pickers presented special cleaning problems which made the cotton difficult and, at times, impossible to handle adequately in conventional equipment. The scope of the problem increased with the spread of mechanical strippers to the medium- and high-rainfall regions, such as east Texas and the Washita valley in Oklahoma. Strippers are operated in those sections before frost to avoid the heavy weather damage and grade deterioration in the open cotton exposed to rains during the harvest season. The open-boll, nonstormproof varieties are subject to heavy field loss during the latter part of the season. To avoid weather damage and field loss, attempts to harvest the cotton when it is 80 to 90 percent open and before frost results in harvestings containing up to 10 percent by weight of green, unopened bolls. Such large quantities of green bolls in the seed cotton cause time-consuming chokages in the gin and excessive grade reductions. The green bolls

are broken by the cleaner cylinders and are speared and cut by the extractor saws, resulting in a sticky, high-moisture material which becomes mixed with the cotton. This mixture sticks to the cleaner screens and extractor saws, reducing the cleaning efficiency of the machines even before chokages occur. The sap from the bolls often causes further trouble occasioned by lint sticking to the gin saws, which must be "picked" by hand. As most ginners know, this costs them a loss of several hours of valuable ginning time.

The primary objection to green bolls in cotton is that they cause grade reduction and time lost due to chokages, but secondarily they sometimes contribute indirectly to gin fires.

Other extraneous material such as rocks and tramp metal became an increasing hazard with rough harvesting methods. More overhead cleaning machinery is required to handle these rough cottons which contain a preponderance of vegetable matter. The more cleaning machinery there is in a plant, the greater the potential becomes for damage from rocks and tramp metal and the greater the danger of fire caused by these types of material. Damages to the extractor saws, beater cylinders, cleaner rollers and screens, and gin saws sometimes cause prolonged shutdowns and excessive repair costs. A survey [1] made during the 1953–54 ginning season brought out that, of a total of 1,162 gin fires reported, 27 percent were believed to have been caused by metal and rocks, and 8 percent by chokages and friction in the roll box. Thus, the green-boll and rock trap is designed to aid in eliminating the cause of 35 percent of the gin fires reported, and to reduce down time and grade reductions resulting from green bolls harvested with the cotton.

DEVELOPMENT OF THE GREEN-BOLL AND ROCK TRAP

For years rock traps of various designs have been used in air lines at cotton gins and have provided a valuable means for removing rocks and tramp metal from seed cotton. These traps were generally located in the air suction line between the wagon telescope and separator. The designs varied, but in general they provided for an enlarged section in the pipe where the air velocity might decrease to a point where flotation of the seed cotton was barely maintained. This reduced air velocity was then supposed to allow the rocks and other relatively heavy material to settle, so that a leg leading from the enlarged section would provide space for collecting the discharged material, but numerous troubles arose.

Traps of this general type provided fairly good separation of foreign material so long as it was loose and not tightly intermingled

[1] Survey conducted by the National Cotton Ginners' Association in cooperation with the National Cotton Council, Memphis, Tenn.

or wrapped by the wads of seed cotton pulled from the wagon. The efficiency of such traps, however, was only 50 percent or less, and the pressure drop across them was excessive. Their tendency was to drop some usable seed cotton and partially opened bolls, making changes necessary, such as providing airholes in the discharge section of the trap to induce a secondary stream of air for pulling some cotton back out of the trapped material. But this introduction of air further weakened the suction at the wagon, and in some instances made it necessary to increase fan speeds, which in turn required more power.

Development work in 1946 on a more effective green-boll trap was begun at the United States Cotton Ginning Research Laboratory, Stoneville, Miss., as the result of requests from ginners who were attempting to handle mechanically stripped cotton harvested before frost and containing quantities of green bolls.

The ginners had found that it was almost impossible to maintain capacity in their plants because of chokages resulting from saws gumming in the bur machines, feeders, and gins. The first experiments at these gins involved the use of a commercial type of rock trap in the air line, and later a second commercial trap of slightly different design was added. Test runs were much more satisfactory after installation of the two boll traps in series, but it was apparent that many bolls were still passing the traps and getting into the bur machines and cleaners where troublesome chokages continued.

After studying the problem, the laboratory engineers concluded that effective removal could be obtained by a properly designed trap installed at a point where the seed cotton was flowing at a reduced velocity and a fairly uniform rate, and where it was spread out in a thin, wide stream. The most logical place in the system appeared to be the outlet of the vertical tower drier. At this point some drying and fluffing of the open seed cotton have been achieved and differences between the weight of unopened bolls and seed cotton locks are greatly magnified.

It is known that the floating velocity of material in an air pipe is dependent upon the cross-sectional area of the material and its density. Green bolls are heavy and more or less streamlined, so that a much greater air velocity is required to convey them than is required for fluffy locks of seed cotton which are relatively very light in weight and large in cross-sectional area. By using the formula:

$$V = 3{,}250\sqrt{S \times D},$$

where V = the vertical floating velocity in feet per minute (f. p. m.); S = the specific gravity of the material; and D = the diameter in inches of the equivalent cross section of the particle; it is calculated that the

TABLE 1.—*Results obtained by using a green-boll trap in conjunction with the cleaning and extracting equipment on cotton machine-stripped before frost* [1]

Item	With green-boll trap	Without green-boll trap
Green bolls removed by trap, per bale—pounds	83	----------
Trash removed by cleaning machinery—percent	87. 6	86. 5
Foreign-matter content:		
Wagon sample—percent	31. 5	31. 5
Feeder sample—do	4. 3	4. 3
Lint—do	6. 9	7. 0
Grade:		
Index	84. 5	83. 5
Classer's designation	[2] LM	[2] LM—
Bale value—dollars	122. 52	116. 74

[1] Average of 12 replicated lots for ginning.
[2] LM signifies Low Middling; LM— signifies Low Middling minus.

floating velocity for bolls is 3,500 f. p. m., while the floating velocity for seed cotton is only 1,300 f. p. m.

It is obvious, therefore, that for any boll trap to give successful separation, the air velocity at the outlet must be less than 3,500 f. p. m. but more than 1,300 f. p. m. so that the seed cotton can be carried through the trap and out of the machine while the bolls remain in the trap. An air velocity of 1,500 f. p. m. in the trap is recommended. When the air velocity within the trap is kept within the specified limits, the only bolls to be carried through the trap are those that are entangled in a large mass of seed cotton. Thus, a trap should be located where the seed cotton will reach it after passing through a drier or other gentle-action opening equipment, so that the large wads of cotton coming from the trailer will break up.

Utilizing the foregoing information, a boll trap was designed in 1945 and built in the laboratory shop (fig. 1). In 1946 it was installed for operational tests at a commercial gin in the Mississippi delta area where cotton was being harvested by experimental strippers. This cotton contained quantities of green bolls which were effectively removed by the trap after a slight change was made in the location of the sloping shelf.

The trap was installed at the discharge of the tower drier which was operated in a 2-fan system of push-pull air handling. Air readings taken at the entrance to the trap showed an air velocity of 1,500 f. p. m. in the 8- by 48-inch cross section, with zero static pressure measured in inches of water. The location and arrangement proved optimum because there was no air leakage and because the push-pull arrangement produced a zero static pressure at that point. Following this initial installation, other traps of similar design were built and

installed behind driers using air handling arrangements with only 1 fan to push or pull. Precautions were taken in such single fan installations to insure against leakage in the trap and boll-discharge hopper.

The bypass built into these traps was provided to prevent the loss of dry and partially open bolls containing good cotton such as is found in late-season, hand-snapped or stripped cotton. Lowered turnout of such cottons caused by trapping these bolls would be undesirable.

The boll-trap principles proved to be sound, and the difficulties experienced from green bolls crushing in the cleaning machinery and gin stands were minimized. Tests showed that, in addition to making for better gin operation, the use of the green-boll trap gave a higher bale value on cotton stripped prior to frost (table 1). After such suc-

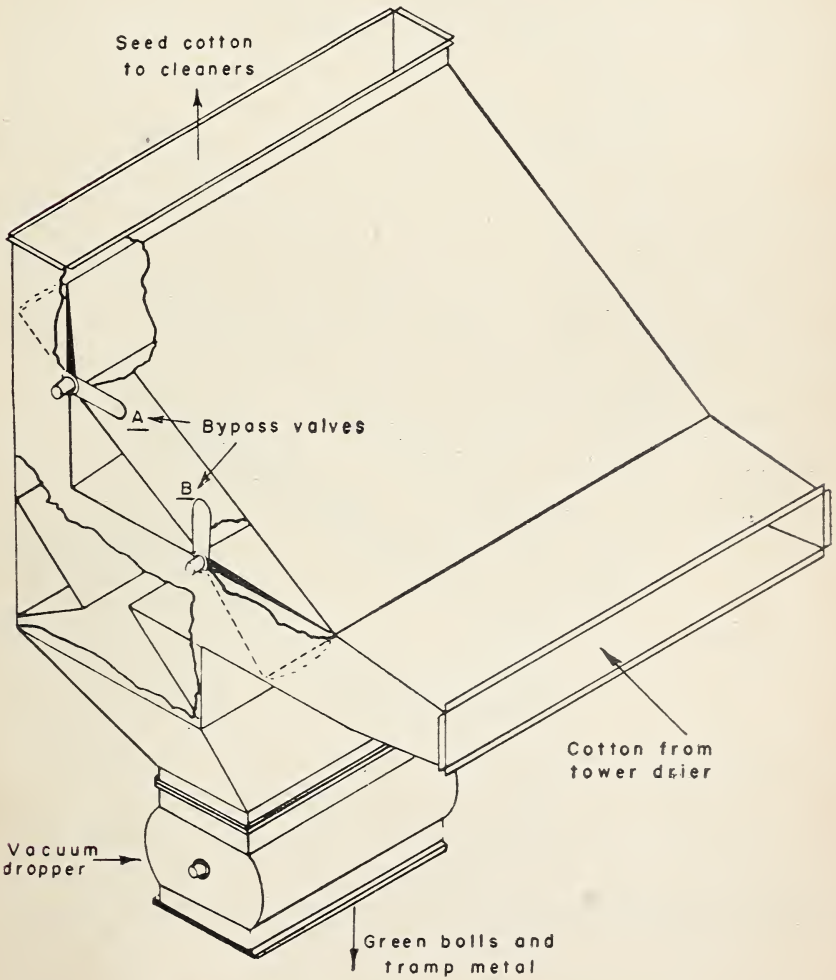

Figure 1.—Original 1946 model green-boll trap.

cessful operational tests, the green-boll trap was quickly accepted by the industry, with several gin-machinery companies and independent machine and sheet-metal shops offering them for sale.

In 1953 the boll trap was redesigned to simplify its construction and reduce manufacturing costs. In the redesigned model, the two bypass valves and the bypass conduit were eliminated (fig. 2). In this simplified model, the inclined deflector in the boll trap is adjusta-

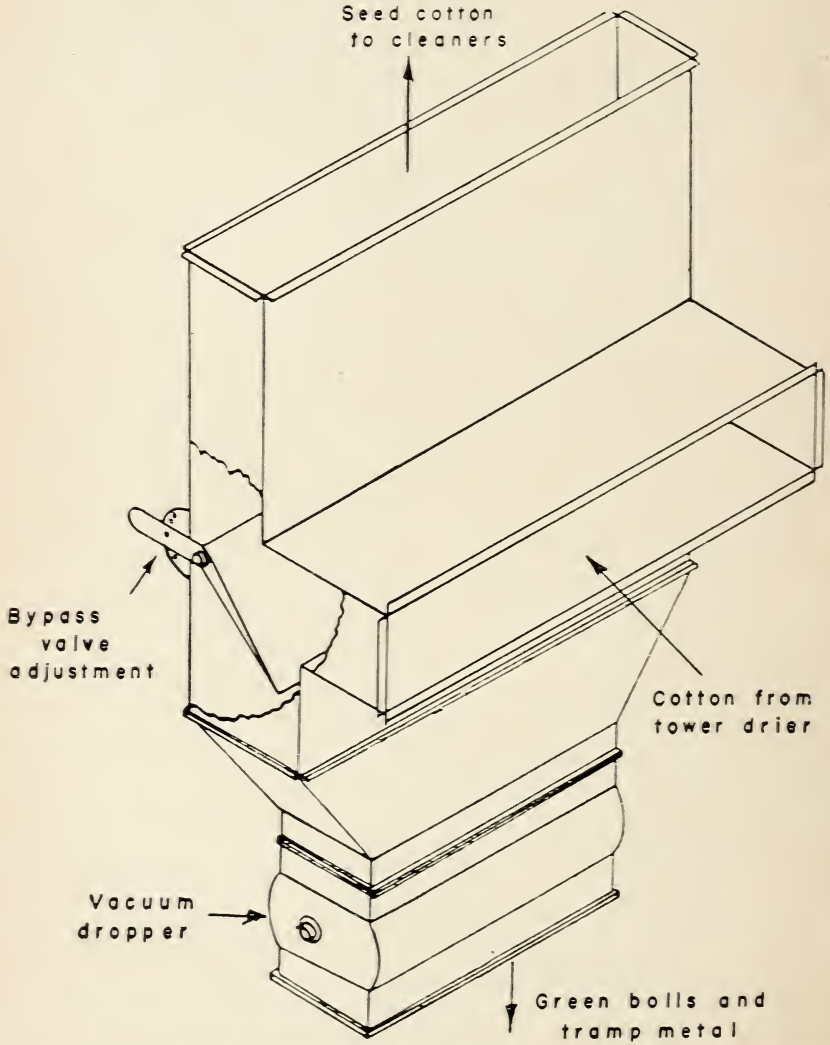

Figure 2.—Simplified, improved 1953 model of green-boll trap showing the adjustable single valve.

ble and serves as a valve to close the trap opening completely and thus prevent the loss of dried bolls: or it may be adjusted to prevent cotton loss in drying systems having low air velocities.

One of these redesigned units was subjected to operational tests in the three-stand laboratory gin during the 1953–54 ginning season. The operational tests gave no indication that the single-valve design changed the effectiveness of the trap.

CONSTRUCTION, INSTALLATION, AND OPERATION OF THE SIMPLIFIED GREEN-BOLL TRAP

The modified trap is of relatively simple construction and can be fabricated by almost any sheet-metal shop. The cost of the device is quite low when compared with that of other gin machinery.

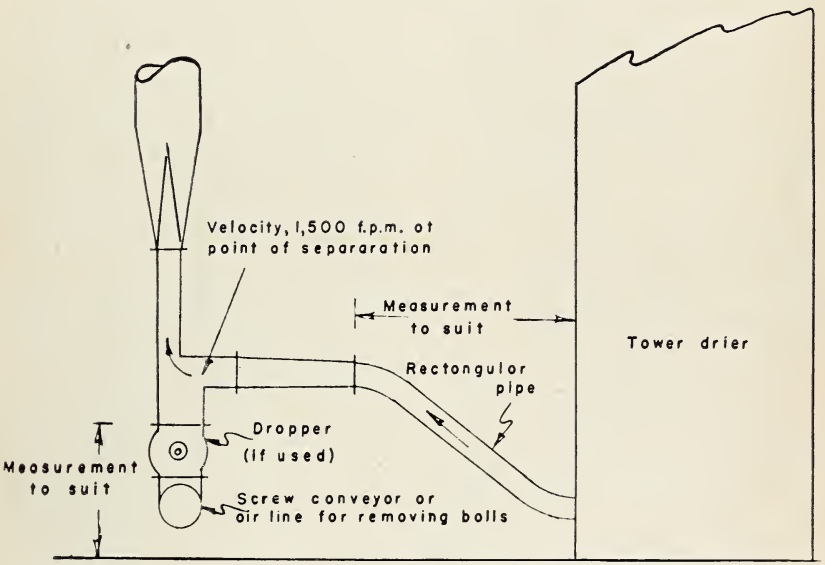

Figure 3.—Location of simplified green-boll trap in the cotton gin, with respect to a tower drier.

As previously stated, the trap operates best when installed at the outlet of a tower drier. Location of the simplified trap is shown (fig. 3). The trap should be connected to the drier with rectangular pipe. Sharp bends in the pipe should be avoided. Elbows should not exceed angles of 60°, and each elbow should have a radius of at least 18 inches. If sharper bends are used, troublesome chokages are likely to occur.

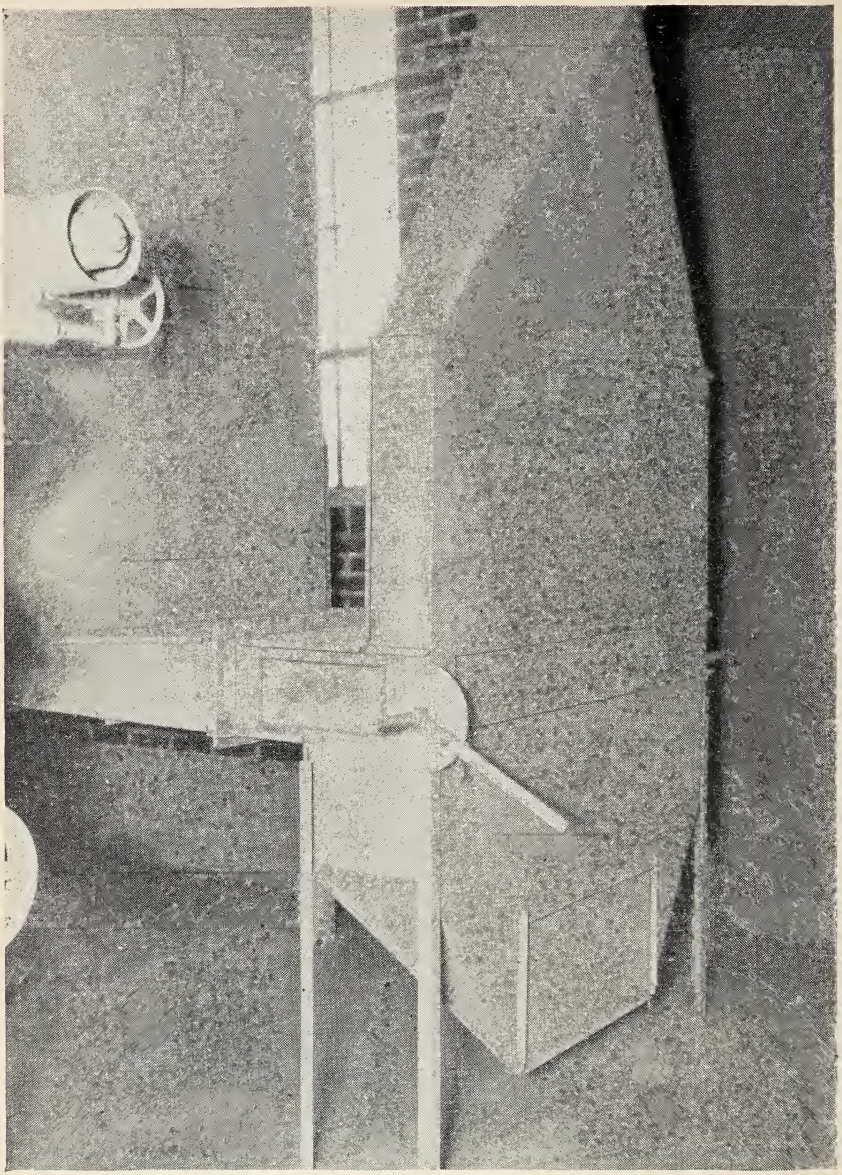

Figure 4.—Green-boll-trap installation in the gin at the United States Cotton Ginning Research Laboratory, Stoneville, Miss.

A simplified trap of this type, installed in the gin at the United States Cotton Ginning Research Laboratory, Stoneville, Miss., is shown (fig. 4). Working drawings for the construction of the trap are shown (fig. 5).

After installation of the trap, the valve should be adjusted while cotton is passing through the system. Correct adjustment of the valve

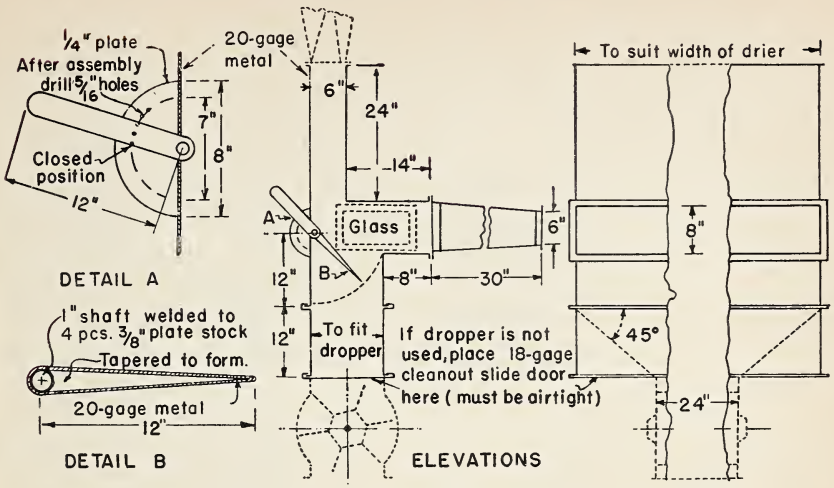

Figure 5.—Construction details of the simplified green-boll trap.

is made by closing it gradually to a point where cotton no longer drops into the trash chamber. The angle of the valve may be slightly different for each installation and is dependent on the air velocity in the trap and, to some extent, the type of cotton being handled. For best overall operation, the air velocity in the trap should be about 1,500 f. p. m. which is the velocity usually found in tower-drier installations.

THE USE OF MAGNETS WITH BOLL TRAPS

Magnets have been successfully installed on the deflector of the original two-valve model boll trap (fig. 6). Magnets aid materially in the removal of small items of ferrous material, such as nails and bottle tops, which would ordinarily be carried through the trap with the cotton. The practice of using a magnet in the boll trap in this manner is rather widespread and has proved to be quite effective.

Magnets are not recommended for use within the single-valve boll trap because the construction of this trap affords no effective location for the magnet. Instead, it is recommended that the magnet be located in the side of the tower drier so that the cotton will strike it as it leaves the last tower shelf (fig. 7). Installations of this type have proved quite satisfactory.

To facilitate trash disposal, either model of the boll trap may be equipped with a vacuum dropper, at least 24 inches in length and driven at about 50 revolutions per minute (r. p. m.). to drop the foreign matter from the trap into an air line or screw conveyor. A dropper on the trash hopper is recommended in lieu of an airtight

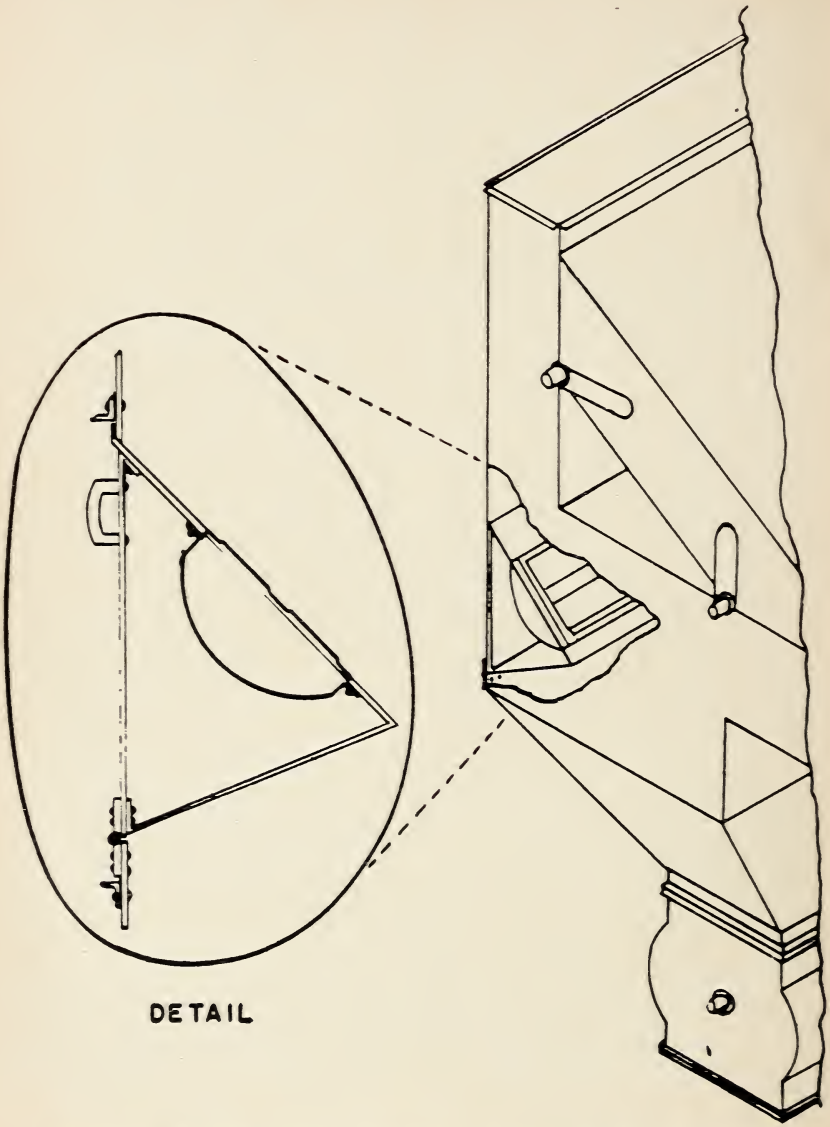

Figure 6.—Typical magnet installation in original two-valve model green-boll trap.

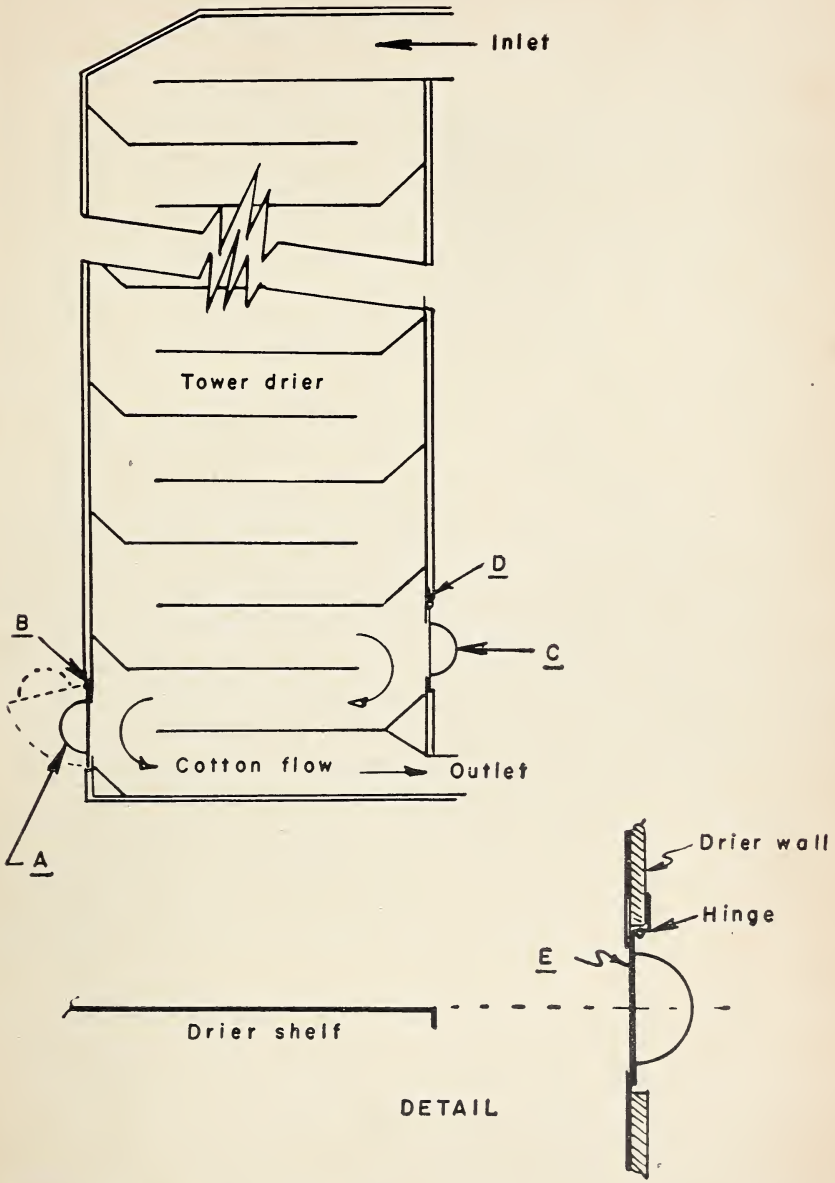

Figure 7.—Magnet installation in a tower drier: *A*, Location of magnet in tower drier; *B*, magnet hinge; *C* and *D*, alternate location of magnet and hinge; *E*, detail of magnet installation in drier wall.

door, to relieve the gin crew of the responsibility for cleaning the trash chamber at frequent intervals and disposing of the foreign matter by hand.

SUMMARY

The green-boll trap was designed and built to remove from seed cotton the extraneous material that normally causes grade reduction, chokages in the overhead machinery, and damage to gin stands or machinery. Surveys show that a successful green-boll and rock trap should aid in eliminating the cause of about 35 percent of gin fires.

For a number of years, traps of various types have been made for use in the wagon-telescope line but have not been entirely satisfactory. It has been determined that to be highly effective a trap must be relatively large so that the cotton can pass through it in a thin layer at low velocity, thus creating conditions for the automatic removal of heavy material. The outlet of a tower drier is the best location to satisfy these requirements.

The 1946 model trap was constructed of 20-gage sheet metal and equipped with bypass valves. It was installed in a gin having a push-pull drying system, and after minor adjustments it worked quite satisfactorily. The following season, boll traps were found to operate satisfactorily in gins having either blow-through or suction drying systems. The principles employed proved sound; the difficulties experienced from green bolls being crushed in the cleaning equipment and gin stand were minimized; and bale-value increases ranging to more than $5.00 per bale were realized. The trap also proved effective in the removal of rocks and relatively heavy tramp metal.

The trap was redesigned in 1953 to simplify its construction and reduce the cost of manufacture. The principle of operation was not changed, but better adjustment to prevent the loss of cotton was provided. Tests made during the 1953–54 ginning season showed this newly designed, single-valve trap to be as effective as the double-valve model.

The green-boll trap should be connected to the drier with rectangular pipe. Sharp angles in the pipe should be avoided. After installation, the valve in the redesigned model should be adjusted while cotton is passing through the system. Magnets may be used quite effectively in connection with the boll trap for the removal of relatively light-weight ferrous material which would ordinarily be carried through the trap with the cotton. Either model of the boll trap may be equipped with a dropper to dispose of the foreign matter into an air line or screw conveyor.

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